PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
DH/LH/G5357		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/04087	03/12/1999	04/12/1998
International Patent Classification (IPC) or national classification and IPC H01B1/24		
Applicant PJO (INDITHERM) LTD et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 22 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
15/04/2000	03.04.2001
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Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/04087

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-12	as received on	23/02/2001	with letter of	22/02/2001

Claims, No.:

1-32	as received on	23/02/2001	with letter of	22/02/2001

Drawings, sheets:

1/5-5/5	as received on	11/02/2000	with letter of	10/02/2000

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   ☐ the language of publication of the international application (under Rule 48.3(b)).
   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.
   ☐ filed together with the international application in computer readable form.
   ☐ furnished subsequently to this Authority in written form.
   ☐ furnished subsequently to this Authority in computer readable form.
   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:
   ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-32.

because:

☒ the said international application, or the said claims Nos. Cls.1-32 relate to the following subject matter which does not require an international preliminary examination (*specify*):
see separate sheet

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 8-32 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☒ the claims, or said claims Nos. 1-8,21 are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N) Yes: Claims 0

	No:	Claims	
Inventive step (IS)	Yes:	Claims	0
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-32
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1.) The following objections in view of Art. 34(b) PCT are made:

The term "flexible semi-conductive material" was not disclosed in the originally filed application. Clearly stated: a flexible fabric was originally disclosed.

In Cl.2 an elastomer polymer is claimed. Originally an elastomeric carrier is disclosed.

Present Cl.3 is not fully supported by originally filed Cl.4. In originally filed Cl.4 a semi-conductive film or coating is disclosed. In present Cl.3 the percentual amount of an elastomeric polymer is claimed. In originally filed Cl.4 the percentual amounts refer to polymers in general (e.g. including coatings).

In Cls. 3-6 the term "flexible conductive material" is used. In originally filed Cls. 4-7 (which partiallly support the above Cls. 3-6) the word flexible is not disclosed.

Cl.7 is only partially supported by Cl.13. Referring to Cls. 1-6 is not supported in the application as originally filed.

Cl.8 is not fully supported by originally filed Cl.8. The terms "flexible electric semi-conductive" and "elastomeric polymer base" were originally not disclosed. Referring to Cl.1 was originally not disclosed.

The flexible fabric according to Cl.21 was originally not characterized by referring to a material according to present Cl.1

To conclude: present Cls. 1-8 and 21 do not fulfill the requirements of Art. 34(b) PCT and, therefore, novelty and inventive step are not assessed.

2.) A problem concerning unity of the invention (Rule 13 PCT) might have to be raised in the following procedure:

Presently, in Cls.1-7 a **conductive material** is claimed.

In Cls. 8-17 a **method for providing the above conductive material** is claimed. The latter has to comprise an anti-adsorption compound.

In Cls. 18-20 **a web or sheet, coated with the above conductive material**, is characterized by process features.

In independent Cl.21 a **flexible fabric coated with a "finished compound"** is claimed. The "finished product" is not specified.

In Cls. 22 -24 a **flexible fabric coated with the above conductive material** is claimed.

In Cls. 25-26 an **electrical connection** is claimed.

In Cls.27-28 a **web or sheet** is claimed.

In Cls. 29-30 a **method of operating a heater** is claimed.

In Cl.31 a **method for providing a heater on an installation** is claimed.

In independent Cl.32 **a method for providing a heater for a product** is claimed.

To conclude: The applicant should be aware that a unity objection might have to be raised in the following procedure. The first set of Claims, e.g.Cls.1-7 does not fulfill the requirements of Art. 34(b). Therefore, presently it cannot be assessed if they are novel, e.g. the distinguishing feature in view of the prior art cannot be defined. Furthermore, it cannot be assessed if the distinguishing feature might comprise the common inventive concept of the invention for all presently claimed products and methods.

3.) The following objections concerning lack of clarity (Art. 6 PCT) are made:

Cl.6:The elastomeric polymer is a "polymer in solution". Does the applicant want to claim a solved elastomeric polymer? The applicant is invited to give further clarification.

Cl.8: The wording "with the maintenance of the mixture below a predetermined level" lacks clarity. Which sort of level is meant? What is an "anti-adsorption compound" ?

The wording "suitable" in **Cl.10** does not serve to render the Claim clear.

Cl.13 refers to "adsorbants" according to Cls. 8-12. In Cls. 8-12 adsorbants are not mentioned.

In **Cl.15** the polymer solution is said to be an aliphatic polyurethane. The wording solution gives the impression that a solvent is present. The applicant is invited to give further clarification.

Cl.25 refers to coatings according to Cls. 1-24. In Cls. 1-17 coatings are not mentioned.

The wording "preferably wider" in **Cl.26** lacks clarity.

Cl.27 refers to webs or sheets according to Cls. 18-26. In Cls. 21-26 webs or sheets are not mentioned.

Cl.29 refers to heaters according to Cls. 1-28. Cls. 1-7 do not concern heaters.

What is meant by the wording "strategically located temperature" in **Cl.30**. What is meant by the wording "..,that signal...". It appears, that "...,to signal.." is meant.

In **Cl.31** it is referred to compounds provided by the method according to Cls. 8-17. It seems doubtful if the said compounds can be clearly defined by the process features of Cls.8-17. If it is possible, products should be clearly defined by product properties.

Neither the polymer, nor the amount of carbon particles is specified in **Cl.32**. Obviously, claimed subject-matter is defined by the problem which should be solved. Furthermore, it appears that defining a polymer by the term "appropriate" lacks clarity.

An assessment of novelty and inventive step of Cls.8-32 makes no sense until the said Claims are amended under consideration of Art. 6 PCT and Rule 13 PCT.

CONDUCTIVE MATERIALS

This invention relates to conductive materials and is particularly concerned with conductive materials to serve the purpose of a heating means.

It has long been known that materials that are electrically conductive can generate heat. This phenomenon has spawned a considerable number of heating means for a considerable number of different purposes.

Whilst electrical heaters at large are generally successful, and more than capable of meeting their intended purpose, what has proved to be difficult, is the achieving of a uniform heating effect over a relatively wide area, substantially free from hot and cold spots or areas.

There have been attempts hitherto to create electrical heaters in sheet or web form to serve a wide variety of purposes. However, the most usable form of conductive material is in the form of carbon particles or carbon black embedded in or coated on a carrier or substrate. To attempt to achieve a uniform heating effect, a greater density or concentration of carbon particles is employed, but as a direct result of that, the material becomes less pliable and more brittle, to the detriment of the employment of the material over a wide range of potential uses.

The first object of the present invention is to provide a start or batch material able to be used in a variety of different physical forms to suit a wide variety of electrical conduction heaters.

Second and subsequent objects of the invention are to transform the start or batch material into products that are electrical conductive heaters for a wide variety of different purposes.

According to a first aspect of the present invention, a flexible semi-conductive material comprises finely divided carbon particles uniformly dispersed in an elastomeric polymer there being carbon particle levels of 20% by weight to 75% by dry weight to 80% to 25% by dry weight of elastomeric polymer levels, the material also including an anti-adsorption compound.

Carbon particle levels of 20% to 40% by dry weight to 80% to 60% by dry weight of

carrier levels can be used.

According to a further feature of the invention, a semi-conductive film or coating comprises a carbon filled elastomeric polymer, preferably with carbon particle levels of 43% to 73% by dry weight to 57% to 27% by dry weight polymer levels, preferably 60% by dry weight to 65% by dry weight. Further preferably, the carbon particle level is 57% by dry weight.

The elastomeric polymer may be an aliphatic polyurethane in solution, and desirably the carbon particles are mixed without milling prior to the addition thereto of the polyurethane solution.

If required in particular applications, flame retardant materials may be provided.

According to a further aspect of the invention a method of forming a compound for a flexible electrical semi-conductive heater comprises stirring fine carbon particles into a polymer base containing an anti-adsorption compound, to achieve carbon particles to polymer levels of 20% by dry weight to 75% by dry weight to 80% to 25% by dry weight of polymer, and subjecting mixture to high speed stirring for a pre-determined period of time, with the maintenance of the mixture below a predetermined level, to grind the carbon particles to a predetermined final fineness. The predetermined level may be at not more than 25 °C

The required carbon particle level may be 20% to 40% by dry weight to polymer level but preferably carbon levels are from 43% to 73% by dry weight to polymer, and more particularly 57% by dry weight.

The resultant mixture exhibits thixotropic rheological properties, and if required, the viscosity of the mixture can be reduced, by the addition of a suitable solvent such as dimethylformamide.

Preferably the carbon black particles have particulate size of approximately 30 En nm. Suitable adsorbants may be selected from the group containing polypropylene glycols, and

polyethylene glycols of a required molecular weight. After this process is complete a suitable polymer solution eg an aliphatic polyurethane is added to the master batch such that the ratio of polymer to carbon black is 1:0.57 on a dry basis. The finished compound is then refiltered prior to any coating process.

The duration of the slow stirring-in of carbon black is not critical, but desirably high speed stirring is limited to not more than 30 minutes.

Once the mixture is prepared, it is checked by taking a sample and passing it through a 200 mesh filter, preferably with the aid of a low pressure displacement pump, and checked by using a Heckman gauge, to ensure that there has been no agglomeration of the carbon particles during mixing. If any agglomeration is detected, the mixture should be subjected to further high speed stirring.

Preferably, the prepared start or batch material is subjected to a final filtration step by passing the mixture through a 300 mesh filter cloth, for example by way of a slow, low pressure positive displacement pump, at which stage there should be no residue left on the filter cloth that would signal that there was still a degree of remnant agglomeration of carbon particles.

In the form where the start or batch material employs dimethylformamide as the solvent and polyethylene or propylene glycol as the polymer base, it constitutes an ideal material to serve as a coating or a base or carrier material.

According to a further aspect of the invention a web or sheet is formed by applying a quantity of finished compound as discussed above to a release paper by way of transfer coating, to achieve a uniform coating or film of compound between 90 and 100 grams per square meter dry weight, and subjecting the web or sheet to heat progressively rising from 110 °C to 150 °C to achieve the controlled release of solvents and provide a coating or film free of pinholes.

As the electrical conductivity, and hence the heating effect achievable is a function of

coating or film thickness the above process is repeated until a desired thickness of coating or film is created.

At this stage considerable care must be exercised to ensure that reticulation is avoided, and as it is preferred to spread the finished compound on the release paper by employing a doctor blade, equally considerable care exercised to ensure the avoidance of the presence of dirt or grit on the blade edge, to prevent the creation and spread of lines of indentations in the coating or film.

Desirably, the release paper is matt grade and is an unembossed silicone-coated paper.

According to a still further aspect of the invention, a flexible fabric able to serve the purpose of an electrical conductive heater is formed by taking the release paper mentioned above with its coating of finished compound spreading thereon a further quantity of said compound, laying the release paper on a flexible fabric carrier sheet or web, and passing the composite through a fixed gap roller to ensure controlled penetration of said compound into the fabric of the sheet or web, the sheet or web thereafter being subjected to heat progressively rising from 110 °C to 150 °C to achieve controlled release of solvents and provide a coating of film free of pinholes. Also possible is the direct application of a coating of finished compound directly on to a fabric carrier.

Such a sheet or web can be of any desired length, and of any width with the limits of available fixed gap rolls.

By the nature of the coat or film, there is a substantially totally even spread of carbon black at loadings in the polymer material considerably beyond that which has hitherto been believed to be possible whilst at the same time leaving the fabric with its film or coat totally flexible.

The fabric may be a knitted cotton material but can be of any other suitable form, such

as a weft knitted polyvinyl alcohol fabric.

The preparation of the said compound and the manner of its application to a carrier is such that a visually smooth coating or film is provided. However, it remains so that the coating will exhibit a microscopic degree of roughness with peaks and troughs formed by carbon particles at the exposed surface. It is then important to pay special attention to the provision of an electrical connection to the coat or film.

According to yet another aspect of the invention an electrical connection to a coat or film incorporating carbon particles is formed by first spraying a nickel compound to an area of the coat or film, and applying to the sprayed area a tin-copper tape coated with a silver loaded conductive adhesive. With the electrical connection installed, the sheet or web can be connected to a suitable power source with the substantial guarantee that there will be no shorting or arcing at the point of electrical connection, and consequently no damage by the creating of hot spots.

Dependant on the use to which the sheet or web is put, an electrical connection can be provided over long lengths to opposite edges, to assist in the even input of power to the coat or film over a wide area, by locating a conductive rail on the silver loaded conductive tape. Desirably, the conductive rail is overlaid by an antifaying compound, preferably wider than the rail.

An important aspect of the invention is that the totally uniform heating effect achievable in the coat or film can be with relatively low power, eg 24 volts, and by controlling the width between the electrodes or rails, and the thickness of the coat or film, a constant temperature can be achieved and maintained, at any required level to serve a particular purpose.

In its form as a flexible sheet or web, an outer insulating layer can be sprayed on to form a water/fluid resistant electrical insulator. Suitable materials may be polyurethane, silicone or acrylic elastomers. The invention has a considerable number of available uses. It can be

wrapped round an article the temperature of which is to be maintained and equally can be incorporated into clothing for use in extremely cold climates, to maintain the temperature of the wearer.

However, the fabric has significant benefits when used in medical contexts. It can be ncorporated in a mattress or as a blanket for an operating table or for a bed in the recovery ward for raising and maintaining the temperature of patients following surgery.

It is possible to employ the fabric in sleeping or carrying bags for use by rescue services to give immediate aid to accident victims suffering from hyperthermia.

In all such uses, the low voltage required means that there is total safety to the user. The voltage and coat or film thickness can determine the maximum and constant temperature across the full width and length of the fabric.

The arrangement may be that power is supplied to the electrically conductive heater until such time as its required temperature is reached and then maintained at that temperature by an appropriate switching arrangement to switch power ON and OFF as required. It is however preferred for power to be supplied as a series of pulses of predetermined time, with intervening periods where power is switched off for predetermined periods of time, to allow temperature sensing to take place. Irrespective of the form of power supply, the invention allows highly efficient use of electrical power.

In addition to being able to control maximum temperatures by voltage control by control of the spacing between electrodes and by coating thickness it is a highly advantageous feature of the invention that the predetermined maximum temperature to suit the application is achieved in reasonable time from the onset of power, after which the temperature is regulated and maintained at its predetermined level. This can be of considerable importance not only in medical contexts but also in such as the food industry and particularly in food processing where a required

temperature must be achieved quickly and maintained.

In addition to its use in conjunction with a flexible fabric, the said compound can be used differently. For example, it may be sprayed onto products whereby to provide heat uniformly over the whole surface of a complex product. The said compound can be screen printed onto support surfaces, or can be directly coated on to a product surface. Equally it can be calendered or hot melt coated from dry compound to produce flexible sheets, or can be applied by a powder coating technique to produce heatable laminates.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic part sectional perspective view of a mattress or blanket containing a conductive material in accordance with the invention;

Figure 2 is a schematic plan view of a mattress or blanket as in Figure 1;

Figures 3 is an upper and view of an electrical connection to the conductive material;

Figure 4 is an exploded perspective view of the electrical connector of Figure 3;

Figure 5 is an electrical block diagram illustrating an electrical circuit able to cause the heating of and the maintenance of a constant temperature in the conductive material; and

Figure 6 and 7 are schematic illustrations of a blanket essentially as shown in Figure 1 formed as a wrapping or a surround for a product structure or pipe;

In Figure 1, a blanket or mattress 1 has a core 2 formed by conductive material 3 on a fabric support 4. The conductive material was produced by the method hereinbefore defined, and applied to the fabric layer as a series of coatings, with each coating heated to 110°C to 150°C by passing through an oven or a series of ovens before the application of a succeeding coating. For medical use, the coating can be 144 microns thick. The conductive material 3 on its fabric support 4 is overlaid by an electrical insulating layer 5, and both encased in a flame retardant

insulation 6, of greater thickness to the rear or non-operative side 7 than to the front or operative side 8.

The whole composite is encased in an outer casing 9 of a polyurethane material, and the edges fully sealed around the full periphery of the blanket or mattress, to ensure that the blanket or mattress is totally waterproof, and readily cleanable and sterilisable.

On the conductive material 3 and below the electrical insulating layer 5, is a conductive rail 10 which, as is shown more particularly by Figure 2, lies along the edges of the conductive material along its two longer lengths. For medical use, the spacing between the rails may be 460 mms.

The provision of a guaranteed electrical connection to the conductive rail is of particular importance, and arcing or shorting of the electrical supply must be avoided. Of a separate significance is the supply of current to the conductive material within the blanket or mattress, and as shown in Figures 1, 3 and 4 this is achieved by applying a coating 11 of nickel over the length and width of the conductive material to be occupied by the conductive rail 10 on to which is applied a silver loaded adhesive tape 12 to which the rail 10 is attached. Overlaying the rail 10 is an antifaying compound 13 to guarantee the absence of any electrical arcing. Extending through co-operating apertures in the conductive layer, the nickel coating and the adhesive tape is a conductive stud 14 extending to a stud base 15 soldered to the rear face of the conductive material 3, the stud passing through the fabric backing to cap 16, the cap being crimped to provide a connection to an electrical lead 17. Figure 5 is an exploded view showing the connection.

As indicated in Figure 2, thermocouples or thermisters 18 chosen to suit a particular use of the blanket or mattress (thermistors for sensitive applications and thermocouples for more robust applications), are strategically located on the conductive material, with leads extending

to a connection 19. As indicated in Figure 5, there is a control unit 20, from where emerge electrical leads 21 for the conductive studs 14, there being a one shot or resettable fuse 22 provided in the lead extending to one of the conductive studs 14.

The blanket or mattress discussed above is ideally suited to medical use to serve as a mattress or overlay for an operating table in a theatre or a recovery bed in a recovery room, or as a blanket to overlie a patient. Here the more sensitive thermistor would be employed to sense the temperature of the mattress overlay or blanket. As indicated in Figure 5, the mattress overlay or blanket is connected to a control unit 23 in turn connected to a transformer unit 24 that itself is connected to a mains supply. This ensures that low voltage supply, preferably at 24 volts is supplied to the mattress overlay or blanket.

Figure 5 illustrates in block diagram form the electrical circuit from the mains to the blanket or mattress. At the transformer unit 24, there is the mains input leading to a filter 25 and the low voltage transformer 26. This ensures the feeding of 24 volt supply to the control unit 23. From the inlet, power is supplied to a switching circuit 27, and then to an over temperature isolation circuit 28 from where it progresses to a power output for connection to the mattress overlay or blanket as has been described above. Simultaneously, power is supplied to a control module 29 having a temperature control means 30 and outputs connected to a visual alarm 31 an audible alarm 32 and to the switching circuit 27. The temperature sensing thermistors (or thermocouples) 18 on the mattress overlay or blanket are connected to the control unit 23, to provide signals to the temperature isolation circuit 28 denoting temperature. An alarm test 33 is provided on the unit, the alarm test being connected to the control module, and able to simulate an over temperature condition.

Immediately prior to the onset of operations, the temperature control means is set to a temperature required of the blanket or mattress, typically average human body temperature. The

transformer unit and hence the control unit and mattress overlay/blanket are connected to a mains supply, and the alarm test activated to confirm that all circuits are active.

The switching circuit is such that at the outset, power is supplied to the mattress overlay or blanket for a predetermined period of time, typically one minute and switched off for a second predetermined period of time, typically 10 seconds. During the period that power is switched off, the temperature sensed by the thermistors 18 is signalled via the control module 29 to the over temperature isolation circuit 28, and if the temperature sensed is lower than the pre-set temperature, power is repeatedly switched on and off and the temperature sensed, until the temperature of the blanket or mattress is that required. When in that condition, power is held off until a fall in temperature of the blanket or mattress is sensed.

With a patient on the mattress overlay, or wrapped in the blanket, any fall in body temperature causes an extraction of heat from the mattress or blanket, immediately sensed by the thermisters, and signals sent to the over temperature control circuit and switching circuit to cause the pulsed supply of power to recommence until such time as the temperature of the blanket or mattress recovers to the pre-set level.

By virtue of the method of producing the carbon laden material at its carbon to polymer density, and as a consequence of the manner of its application to a support fabric, there is the substantially uniform heating over the whole area of the blanket, with a substantially total elimination of hot and cold spots the result of which is that there is total support for the body heat of a patient over his or her full height and width, ensuring that body temperature control crucial to a patient during operations and subsequent recovery, is maintained.

In the most unlikely circumstances that the blanket or mattress should overheat, both the visual and audible alarms are activated, and the over temperature isolation circuit switched to prevent further power supply to the blanket or mattress. To guard against over temperature

being consequent on a momentary surge of power, over temperature sensed during a first ten second switch-off of power can be caused to be ignored, and activation of the alarms and temperature isolation circuit activated only if over temperature is sensed during the second of two successive periods of switch-off of power and temperature sensing.

The above described construction of blanket or mattress and its control, whilst ideally suited to medical applications, can be used without essential changes for other more industrial uses.

As is schematically suggested in Figures 6 and 7 a generally rectangular construction 34 of essentially the same nature as is illustrated in Figure 1 can be used to wrap round an item 35 that needs to be heated.

That item could be a domestic hot water tank, when a uniform heating effect is provided over its whole height, to the considerable benefit of the saving of power by creating a more rapid heat up from cold and a far more efficient maintenance of the temperature of water in the tank.

The item could be e.g. pipework in, e.g. the food industry where the invention can provide both an insulating lagging of pipework through which heated and fluid foodstuffs must flow and the provision of uniform heating over the full pipe work length. Not only does this have major importance during normal operations, but should there be the need to close down operations for any reasons, foodstuffs can solidify. Hitherto, solidified oil-based products in pipe lines has been a major problem. With the invention, recommencement of the provision of heat to the blanket and hence to the pipework has the effect of gently and speedily re-heating the foodstuff to bring it back to a fluid state when flow can recommence.

The item could equally be one of outdoor use in extremely cold climates such as for example valves and pumps, that can be encased in the material of the invention to maintain them at a temperature that allows them to function normally no matter what the ambient temperature

might fall to.

CLAIMS

1. A flexible semi-conductive material characterised by finely divided carbon particles uniformly dispersed in an elastomeric polymer there being carbon particle levels of 20% by weight to 75% by dry weight to 80% to 25% by dry weight of elastomeric polymer levels, the material also including an anti-adsorption compound.

2. A conductive material as in Claim 1, characterised in that carbon particle levels of 20% to 40% by dry weight to 80% to 60% by dry weight of elastomeric polymer levels are used.

3. A flexible conductive material as in Claim 1 or Claim 2, characterised in that it is in the form of conductive film or coating and comprises a carbon filled elastomeric polymer with carbon particle levels of 43% to 73% by dry weight to 57% to 27% by dry weight elastomeric polymer levels.

4. A flexible conductive material as in Claim 3, characterised in that the carbon particle level is 60% to 65% dry weight to 40% to 35% dry weight of elastomeric polymer levels.

5. A flexible conductive material as in Claim 3 or Claim 4, characterised in that the carbon particle level is 57% by dry weight to 43% by dry weight of elastomeric polymer.

6. A flexible conductive material as in any of Claims 1 to 5, characterised in that the elastomeric polymer is an aliphatic polyurethane in solution.

7. A flexible conductive material as in any of Claims 1 to 6, wherein the anti-adsorption compound is selected from the group containing polypropylene glycols and polyethylene glycols.

8. A method of forming a compound for a flexible electrical semi-conductive heater as in Claim 1 characterised by stirring fine carbon particles into an elastomeric polymer base containing an anti-adsorption compound, to achieve carbon particles to polymer levels of 20% by dry weight to 75% by dry weight to 80% to 25% by dry weight of polymer, and subjecting

mixture to high speed stirring for a pre-determined period of time, with the maintenance of the mixture below a predetermined level of temperature, to grind the carbon particles to a predetermined final fineness.

9. A method of forming a compound for an electrically conductive heater as in Claim 8, characterised in that the predetermined temperature level is not more than 25°C.

10. A method of forming a compound for an electrically conductive heater as in Claims 8 and 9, characterised in that the viscosity of the mixture is modified by the addition of a suitable solvent.

11. A method of forming a compound for an electrically conductive heater as in Claim 10, characterised in that the solvent is dimethylformamide.

12. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 11, characterised in that the carbon black particles have particulate size of approximately 30 En nm.

13. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 12, characterised in that the adsorbants may be selected from the group containing polypropylene glycols, polyethylene glycols of a required molecular weight.

14. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 13, characterised in that a polymer solution is added to the master batch such that the ratio of polymer to carbon black is 1:0.57 on a dry basis.

15. A method of forming a compound for an electrically conductive heater as in Claim 14, characterised in that the polymer solution is aliphatic polyurethane.

16. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 14, characterised in that the finished compound is refiltered prior to use.

17. A method of forming a compound for an electrically conductive heater as in any of

Claims 8 to 16, characterised in that the first stirring of fine carbon particles in to the polymer base is a slow stirring, and the high speed stirring is limited to not more than 30 minutes.

18. A web or sheet to serve as an electrically conductive heater, is characterised by applying a quantity of finished compound as in any of Claims 1 to 7, to a release paper by way of transfer coating, to achieve a uniform coating or film of compound between 90 and 100 grams per square meter dry weight, and subjecting the web or sheet to heat progressively rising from 110 °C to 150 °C to achieve the controlled release of solvents and provide a coating or film free of pinholes.

19. A web or sheet as in Claim 18, characterised in that a number of coatings are applied to achieve a desired thickness of coating or film.

20. A web or sheet as in Claim 18 or Claim 19, characterised in that the release paper is matt grade and is an unembossed silicone-coated paper.

21. A flexible fabric able to serve the purpose of an electrical conductive heater is formed by taking a release paper with a coating of finished compound as in any of Claims 1 to 7, spreading thereon a further quantity of said compound, laying the release paper on a flexible fabric carrier sheet or web, and passing the composite through a fixed gap roller to ensure controlled penetration of said compound into the fabric of the sheet or web, the sheet or web thereafter being subjected to heat progressively rising from 110 °C to 150 °C to achieve controlled release of solvents and provide a coating of film free of pinholes.

22. A flexible fabric able to serve the purpose of an electrical conductive heater, characterised in that a coating of finished compound as in any of Claims 1 to 7 is applied directly to a fabric carrier.

23. A flexible fabric able to serve the purpose of an electrical conductive heater as in Claims 21 and 22, characterised in that the fabric is a knitted cotton material.

24. A flexible fabric able to serve the purpose of an electrical conductive heater as in Claims 21 to 23, characterised in that the fabric is a weft knitted polyvinyl alcohol fabric.

25. An electrical connection to a coat or film incorporating carbon particles, as defined in any of Claims 1 to 24, characterised by first spraying a nickel compound to an area of the coat or film, and applying to the sprayed area a tin-copper tape coated with a silver loaded conductive adhesive.

26. An electrical connection to a coat or film incorporating carbon particles as in Claim 25, characterised in that the conductive rail is overlaid by an antifaying compound, preferably wider than the rail.

27. A web or sheet as in Claims 18 to 26, characterised by the presence of an outer insulating and water/fluid resistant layer totally encasing the web or sheet.

28. A web or sheet as in Claim 27, characterised in that the water/fluid insulating layer is a polyurethane, silicone or acrylic elastomer.

29. A method of operating an electrically conductive heater of any of Claims 1 to 28, characterised in that the connection to a source of power is by way of a transformer and a control unit to supply power as a series of pulses of predetermined time with intervening periods where power is switched off for predetermined periods of time.

30. A method as in Claim 29, characterised in that during the periods where power is switched off, the temperature of the heater is sensed by strategically located temperature sensing means, that signal the control unit to continue to supply pulses of power or to signal that a predetermined temperature has been reached and suspend the supply of power.

31. A method of providing an electrically conductive heater on a product or an installation, characterised by spraying, screen printing or directly coating the compound as defined in any of Claims 1 to 17 on to the product or installation.

32. A method of providing an electrically conductive heater for a product or an installation, characterised by the employment of an appropriate polymer material into which the carbon particles are stirred that makes the compound suitable for moulding or casting to provide preformed shapes for application to a product or installation.

5

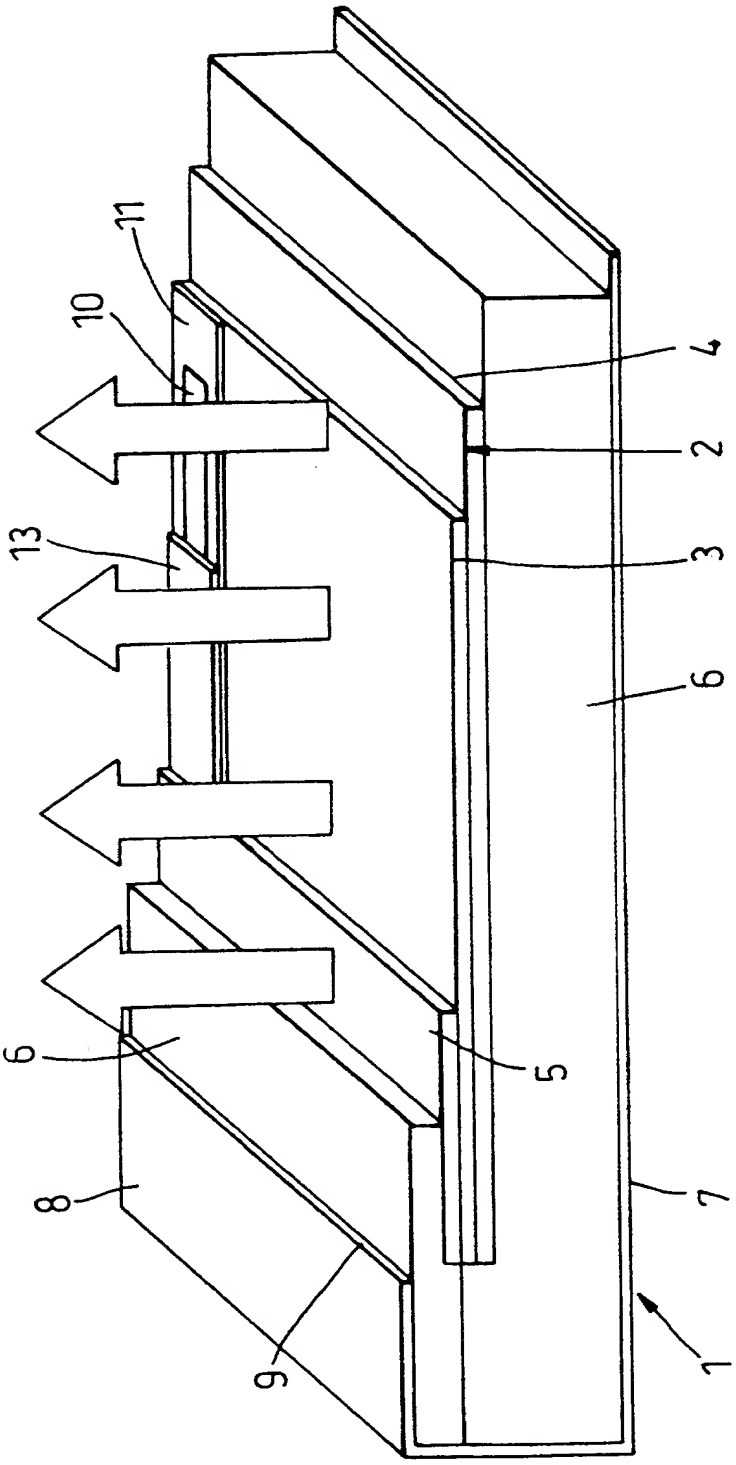


Fig. 1

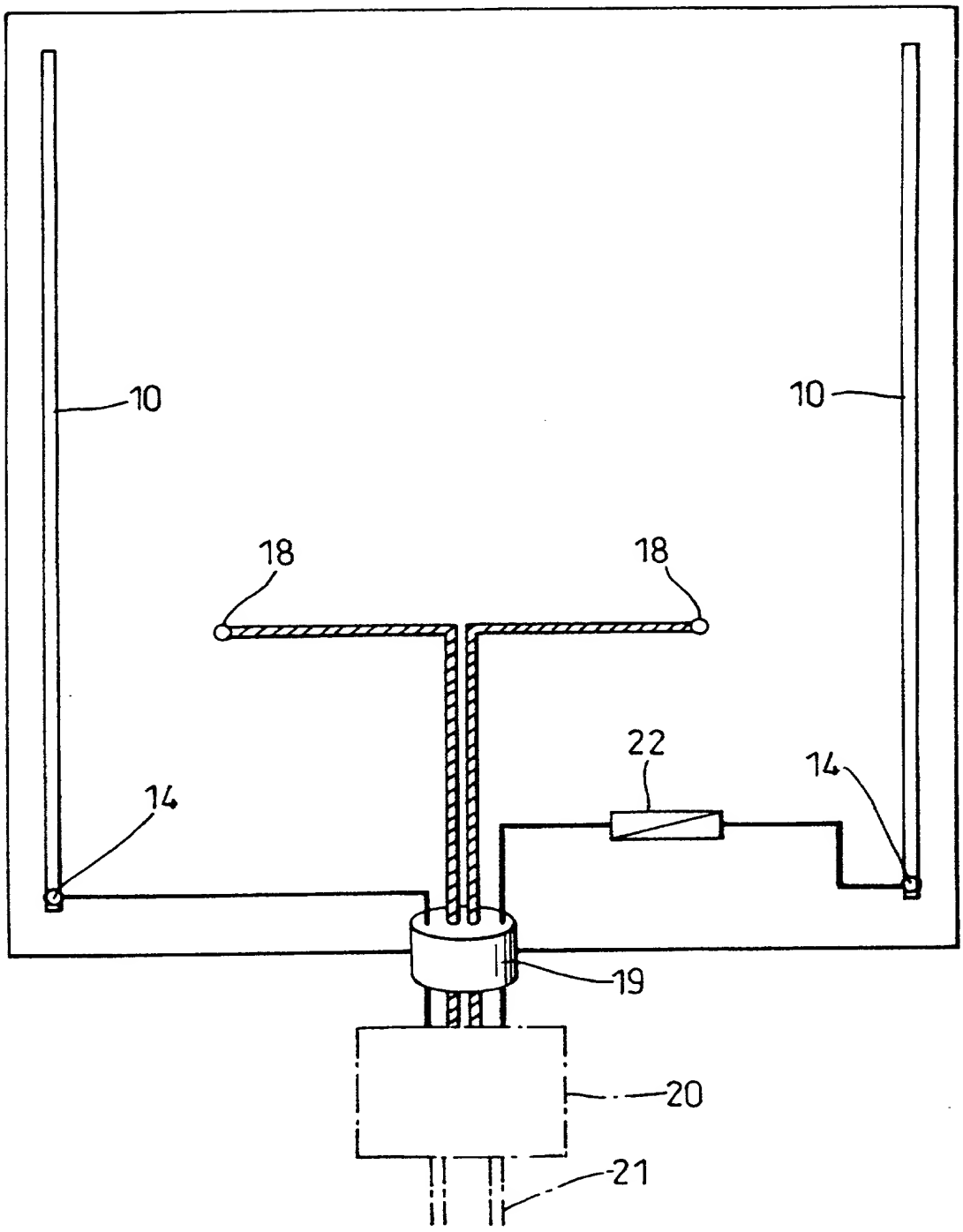


Fig. 2

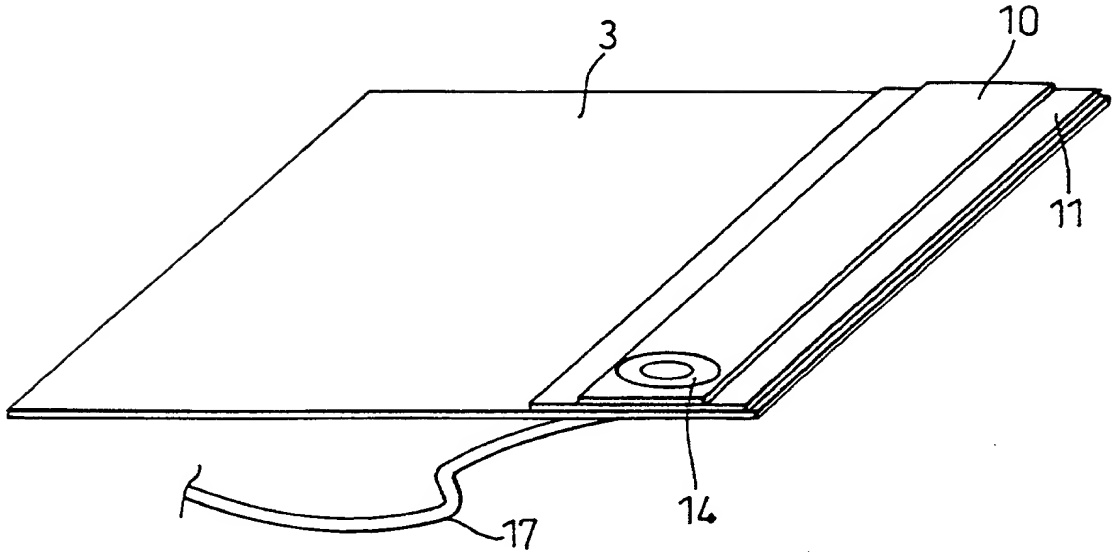


Fig. 3

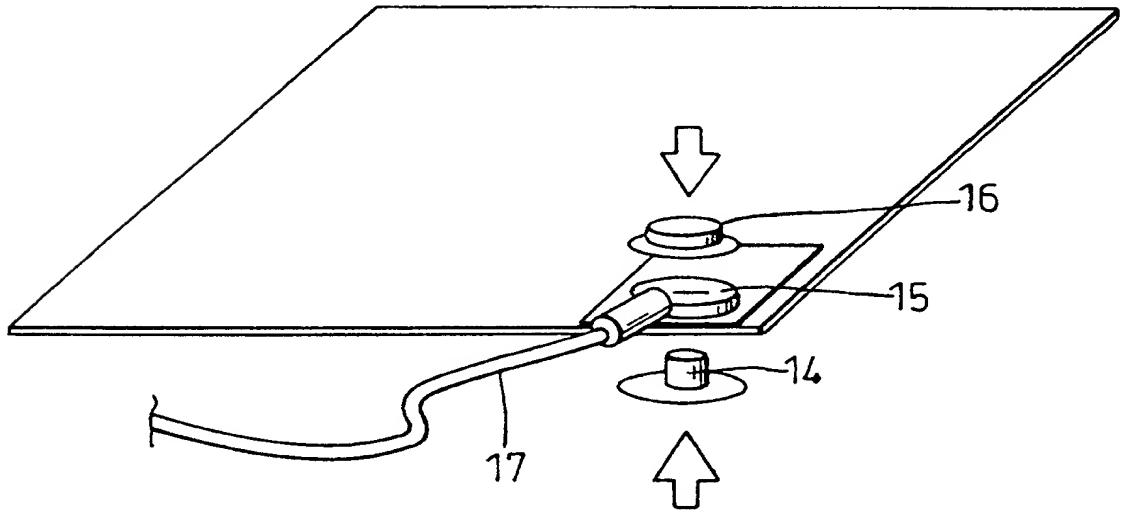
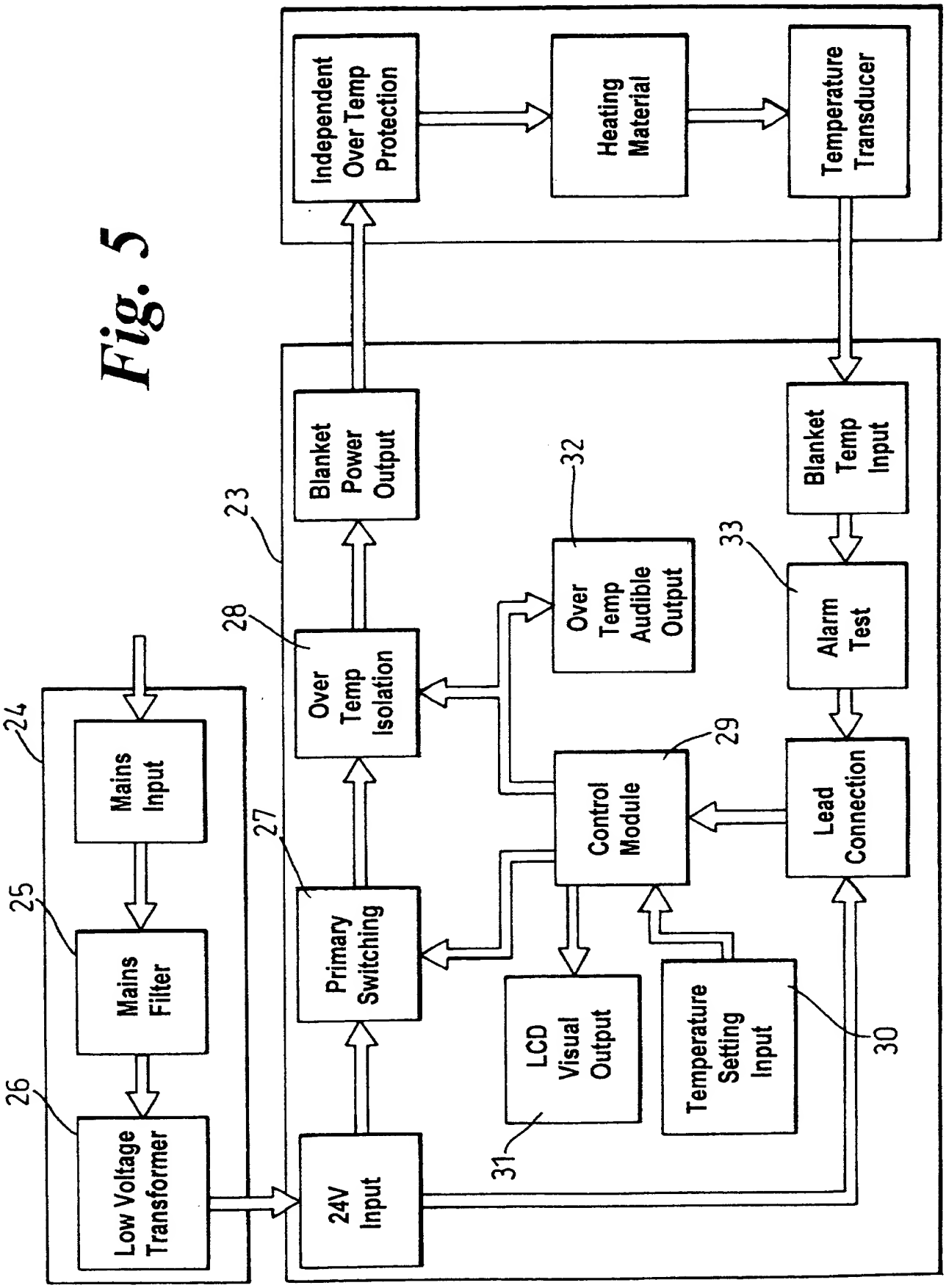


Fig. 4

Fig. 5


Independent Over Temp Protection
Heating Material
Temperature Transducer
Blanket Power Output
Blanket Temp Input
23
32
33
Over Temp Audible Output
Alarm Test
28
Over Temp Isolation
29
Control Module
Lead Connection
24
Mains Input
25
Mains Filter
27
Primary Switching
LCD Visual Output
Temperature Setting Input
30
26
Low Voltage Transformer
24V Input
31

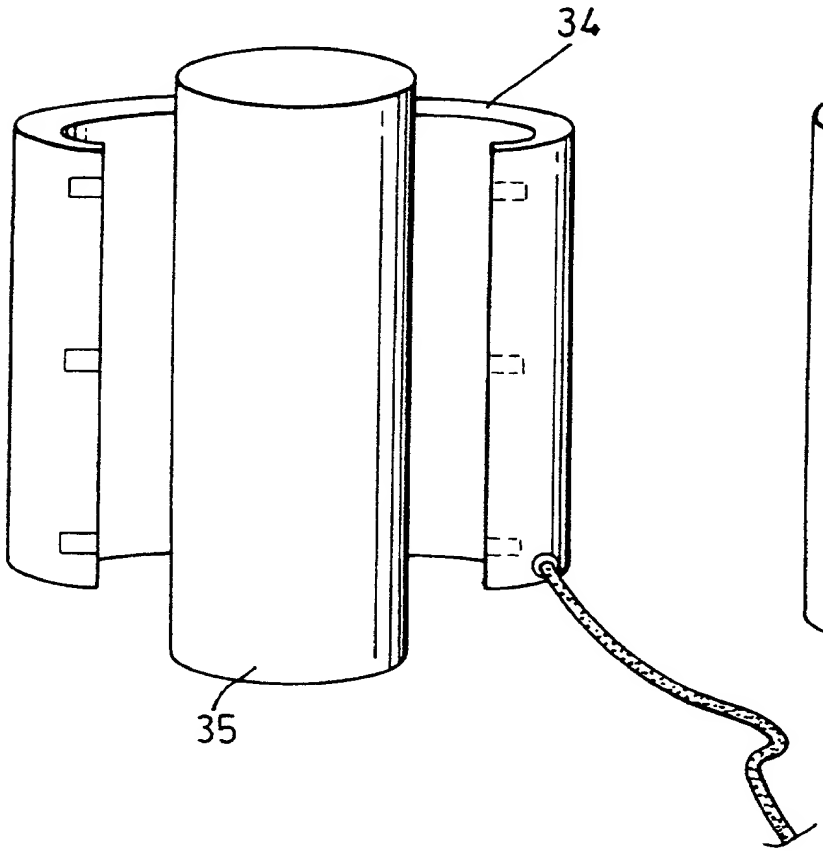


Fig. 6

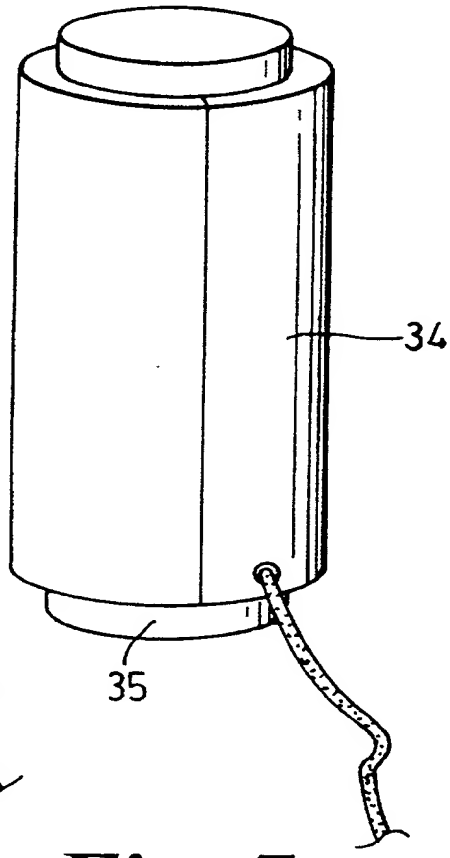


Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/04087

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01B1/24 C08K3/04 H05B3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01B C08K H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 5 902 518 A (KHAZAI BIJAN ET AL) 11 May 1999 (1999-05-11) the whole document	1-8,12, 32
A	WO 94 24678 A (ROMANIEC KAZIMIERZ CZESLAW) 27 October 1994 (1994-10-27) the whole document	1-23, 29-32
A	US 5 250 228 A (BAIGRIE STEPHEN ET AL) 5 October 1993 (1993-10-05) claims 1-14	1-8
A	WO 92 04718 A (RAYCHEM CORP) 19 March 1992 (1992-03-19) the whole document	1-8

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 February 2000	07/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Drouot, M-C

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/04087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 344 734 A (MATSUSHITA ELECTRIC IND CO LTD) 6 December 1989 (1989-12-06) claims 1-12	1-8

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 99/04087

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5902518 A	11-05-1999	NONE	
WO 9424678 A	27-10-1994	AU 6510694 A	08-11-1994
US 5250228 A	05-10-1993	US 5382384 A	17-01-1995
WO 9204718 A	19-03-1992	EP 0548162 A	30-06-1993
		JP 6500662 T	20-01-1994
		US 5925276 A	20-07-1999
EP 0344734 A	06-12-1989	JP 1304683 A	08-12-1989
		JP 2543135 B	16-10-1996
		JP 2008258 A	11-01-1990
		JP 2035702 A	06-02-1990
		CA 1337012 A	19-09-1995
		DE 68920479 D	23-02-1995
		DE 68920479 T	18-05-1995
		KR 9203015 B	13-04-1992
		US 5196145 A	23-03-1993

TENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
DH/LH/G5357		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 99/ 04087	03/12/1999	04/12/1998
Applicant		
PJO (INDITHERM) LTD et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. —

   [ ] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing: 15 June 2000 (15.06.00)	
International application No.: PCT/GB99/04087	Applicant's or agent's file reference: DH/LH/G5357
International filing date: 03 December 1999 (03.12.99)	Priority date: 04 December 1998 (04.12.98)
Applicant: O'GRADY, Patrick, James	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

15 April 2000 (15.04.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/04087

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01B1/24 C08K3/04 H05B3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01B C08K H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 5 902 518 A (KHAZAI BIJAN ET AL) 11 May 1999 (1999-05-11) the whole document	1-8,12, 32
A	WO 94 24678 A (ROMANIEC KAZIMIERZ CZESLAW) 27 October 1994 (1994-10-27) the whole document	1-23, 29-32
A	US 5 250 228 A (BAIGRIE STEPHEN ET AL) 5 October 1993 (1993-10-05) claims 1-14	1-8
A	WO 92 04718 A (RAYCHEM CORP) 19 March 1992 (1992-03-19) the whole document	1-8

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 February 2000	07/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Drouot, M–C

Form PCT/ISA/210 (second sheet) (July 1992)

International Application No
PCT/GB 99/04087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 344 734 A (MATSUSHITA ELECTRIC IND CO LTD) 6 December 1989 (1989-12-06) claims 1-12	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ...ional Application No
PCT/GB 99/04087

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5902518 A	11-05-1999	NONE	
WO 9424678 A	27-10-1994	AU 6510694 A	08-11-1994
US 5250228 A	05-10-1993	US 5382384 A	17-01-1995
WO 9204718 A	19-03-1992	EP 0548162 A	30-06-1993
		JP 6500662 T	20-01-1994
		US 5925276 A	20-07-1999
EP 0344734 A	06-12-1989	JP 1304683 A	08-12-1989
		JP 2543135 B	16-10-1996
		JP 2008258 A	11-01-1990
		JP 2035702 A	06-02-1990
		CA 1337012 A	19-09-1995
		DE 68920479 D	23-02-1995
		DE 68920479 T	18-05-1995
		KR 9203015 B	13-04-1992
		US 5196145 A	23-03-1993

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
DH/LH/G5357		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/04087	03/12/1999	04/12/1998
International Patent Classification (IPC) or national classification and IPC H01B1/24		
Applicant PJO (INDITHERM) LTD et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 22 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
15/04/2000	03.04.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Feldmann, G Telephone No. +49 89 2399 8300

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/04087

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-12	as received on	23/02/2001	with letter of	22/02/2001

Claims, No.:

1-32	as received on	23/02/2001	with letter of	22/02/2001

Drawings, sheets:

1/5-5/5	as received on	11/02/2000	with letter of	10/02/2000

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   ☐ the language of publication of the international application (under Rule 48.3(b)).
   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.
   ☐ filed together with the international application in computer readable form.
   ☐ furnished subsequently to this Authority in written form.
   ☐ furnished subsequently to this Authority in computer readable form.
   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:
   ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-32.

because:

☒ the said international application, or the said claims Nos. Cls.1-32 relate to the following subject matter which does not require an international preliminary examination (*specify*):
see separate sheet

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 8-32 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☒ the claims, or said claims Nos. 1-8,21 are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N) Yes: Claims 0

	No:	Claims	
Inventive step (IS)	Yes:	Claims	0
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-32
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1.) The following objections in view of Art. 34(b) PCT are made:

The term "flexible semi-conductive material" was not disclosed in the originally filed application. Clearly stated: a flexible fabric was originally disclosed.

In Cl.2 an elastomer polymer is claimed. Originally an elastomeric carrier is disclosed.

Present Cl.3 is not fully supported by originally filed Cl.4. In originally filed Cl.4 a semi-conductive film or coating is disclosed. In present Cl.3 the percentual amount of an elastomeric polymer is claimed. In originally filed Cl.4 the percentual amounts refer to polymers in general (e.g. including coatings).

In Cls. 3-6 the term "flexible conductive material" is used. In originally filed Cls. 4-7 (which partiallly support the above Cls. 3-6) the word flexible is not disclosed.

Cl.7 is only partially supported by Cl.13. Referring to Cls. 1-6 is not supported in the application as originally filed.

Cl.8 is not fully supported by originally filed Cl.8. The terms "flexible electric semi-conductive" and "elastomeric polymer base" were originally not disclosed. Referring to Cl.1 was originally not disclosed.

The flexible fabric according to Cl.21 was originally not characterized by referring to a material according to present Cl.1

To conclude: present Cls. 1-8 and 21 do not fulfill the requirements of Art. 34(b) PCT and, therefore, novelty and inventive step are not assessed.

2.) A problem concerning unity of the invention (Rule 13 PCT) might have to be raised in the following procedure:

Presently, in Cls.1-7 a **conductive material** is claimed.

In Cls. 8-17 a **method for providing the above conductive material** is claimed. The latter has to comprise an anti-adsorption compound.

In Cls. 18-20 **a web or sheet, coated with the above conductive material**, is characterized by process features.

In independent Cl.21 a **flexible fabric coated with a "finished compound"** is claimed. The "finished product" is not specified.

In Cls. 22 -24 a **flexible fabric coated with the above conductive material** is claimed.

In Cls. 25-26 an **electrical connection** is claimed.

In Cls.27-28 a **web or sheet** is claimed.

In Cls. 29-30 a **method of operating a heater** is claimed.

In Cl.31 a **method for providing a heater on an installation** is claimed.

In independent Cl.32 **a method for providing a heater for a product** is claimed.

To conclude: The applicant should be aware that a unity objection might have to be raised in the following procedure. The first set of Claims, e.g.Cls.1-7 does not fulfill the requirements of Art. 34(b). Therefore, presently it cannot be assessed if they are novel, e.g. the distinguishing feature in view of the prior art cannot be defined. Furthermore, it cannot be assessed if the distinguishing feature might comprise the common inventive concept of the invention for all presently claimed products and methods.

3.) The following objections concerning lack of clarity (Art. 6 PCT) are made:

Cl.6:The elastomeric polymer is a "polymer in solution". Does the applicant want to claim a solved elastomeric polymer? The applicant is invited to give further clarification.

Cl.8: The wording "with the maintenance of the mixture below a predetermined level" lacks clarity. Which sort of level is meant? What is an "anti-adsorption compound" ?

The wording "suitable" in **Cl.10** does not serve to render the Claim clear.

Cl.13 refers to "adsorbants" according to Cls. 8-12. In Cls. 8-12 adsorbants are not mentioned.

In **Cl.15** the polymer solution is said to be an aliphatic polyurethane. The wording solution gives the impression that a solvent is present. The applicant is invited to give further clarification.

Cl.25 refers to coatings according to Cls. 1-24. In Cls. 1-17 coatings are not mentioned.

The wording "preferably wider" in **Cl.26** lacks clarity.

Cl.27 refers to webs or sheets according to Cls. 18-26. In Cls. 21-26 webs or sheets are not mentioned.

Cl.29 refers to heaters according to Cls. 1-28. Cls. 1-7 do not concern heaters.

What is meant by the wording "strategically located temperature" in **Cl.30**. What is meant by the wording "..,that signal...". It appears, that "...,to signal.." is meant.

In **Cl.31** it is referred to compounds provided by the method according to Cls. 8-17. It seems doubtful if the said compounds can be clearly defined by the process features of Cls.8-17. If it is possible, products should be clearly defined by product properties.

Neither the polymer, nor the amount of carbon particles is specified in **Cl.32**. Obviously, claimed subject-matter is defined by the problem which should be solved. Furthermore, it appears that defining a polymer by the term "appropriate" lacks clarity.

An assessment of novelty and inventive step of Cls.8-32 makes no sense until the said Claims are amended under consideration of Art. 6 PCT and Rule 13 PCT.

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(54) Title: CONDUCTIVE MATERIALS

(57) Abstract

The invention relates to conductive heaters, and has its objective to provide a material that exhibits a uniform heating effect over the full area of the heater, relatively free from hot and cold spots, a further objective being to maintain the heater pliable. These objectives are met by a conductive material comprising finely divided carbon particles uniformly dispersed in an elastomeric carrier there being carbon particle levels of 20 % to 75 % by dry weight to carrier levels. Preferably, the carrier is an elastomeric polymer. A further aspect of the invention is a method of forming a compound for an electrically conductive heater comprising stirring fine carbon particles into a polymer base containing an anti-adsorption compound, to achieve carbon particles to polymer levels of 20 % by dry weight to 75 % by dry weight, and subjecting mixture to high speed stirring for a pre-determined period of time, with the maintenance of the mixture below a predetermined level, to grind the carbon particles to a predetermined final fineness.

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CONDUCTIVE MATERIALS

This invention relates to conductive materials and is particularly concerned with conductive materials to serve the purpose of a heating means.

It has long been known that materials that are electrically conductive can generate heat. This phenomenon has spawned a considerable number of heating means for a considerable number of different purposes.

Whilst electrical heaters at large are generally successful, and more than capable of meeting their intended purpose, what has proved to be difficult, is the achieving of a uniform heating effect over a relatively wide area, substantially free from hot and cold spots or areas.

There have been attempts hitherto to create electrical heaters in sheet or web form to serve a wide variety of purposes. However, the most usable form of conductive material is in the form of carbon particles or carbon black embedded in or coated on a carrier or substrate. To attempt to achieve a uniform heating effect, a greater density or concentration of carbon particles is employed, but as a direct result of that, the material becomes less pliable and more brittle, to the detriment of the employment of the material over a wide range of potential uses.

The first object of the present invention is to provide a start or batch material able to be used in a variety of different physical forms to suit a wide variety of electrical conduction heaters.

Second and subsequent objects of the invention are to transform the start or batch material into products that are electrical conductive heaters for a wide variety of different purposes.

According to a first aspect of the present invention, a conductive material comprises finely divided carbon particles uniformly dispersed in an elastomeric carrier there being carbon particle levels of 20% by weight to 75% by dry weight to 80% to 25% by dry weight of carrier

levels.

Carbon particle levels of 20% to 40% by dry weight to 80% to 60% by dry weight of carrier levels can be used.

The carbon particles may be so-called carbon black, a finely divided powder, and the elastomeric carrier is an elastomeric polymer, and according to a further feature of the invention, a semi-conductive film or coating comprises a carbon filled elastomeric polymer, preferably with carbon particle levels of 43% to 73% by dry weight to 57% to 27% by dry weight polymer levels, preferably 60% by dry weight to 65% by dry weight. Further preferably, the carbon particle level is 57% by dry weight.

The elastomeric polymer may be an aliphatic polyurethane in solution, and desirably the carbon particles are mixed without milling prior to the addition thereto of the polyurethane solution.

If required in particular applications, flame retardant materials may be provided.

According to a further aspect of the invention a method of forming a compound for an electrically conductive heater comprises stirring fine carbon particles into a polymer base containing an anti-adsorption compound, to achieve carbon particles to polymer levels of 20% by dry weight to 75% by dry weight to 80% to 25% by dry weight of polymer, and subjecting mixture to high speed stirring for a pre-determined period of time, with the maintenance of the mixture below a predetermined level, to grind the carbon particles to a predetermined final fineness. The predetermined level may be at not more than 25°C

The required carbon particle level may be 20% to 40% by dry weight to polymer level but preferably carbon levels are from 43% to 73% by dry weight to polymer, and more particularly 57% by dry weight.

The resultant mixture exhibits thixotropic rheological properties, and if required, the viscosity of the mixture can be reduced, by the addition of a suitable solvent such as dimethylformamide.

Preferably the carbon black particles have particulate size of approximately 30 En nm. Suitable adsorbants may be selected from the group containing polypropylene glycols, and polyethylene glycols of a required molecular weight. After this process is complete a suitable polymer solution eg an aliphatic polyurethane is added to the master batch such that the ratio of polymer to carbon black is 1:0.57 on a dry basis. The finished compound is then refiltered prior to any coating process.

The duration of the slow stirring-in of carbon black is not critical, but desirably high speed stirring is limited to not more than 30 minutes.

Once the mixture is prepared, it is checked by taking a sample and passing it through a 200 mesh filter, preferably with the aid of a low pressure displacement pump, and checked by using a Heckman gauge, to ensure that there has been no agglomeration of the carbon particles during mixing. If any agglomeration is detected, the mixture should be subjected to further high speed stirring.

Preferably, the prepared start or batch material is subjected to a final filtration step by passing the mixture through a 300 mesh filter cloth, for example by way of a slow, low pressure positive displacement pump, at which stage there should be no residue left on the filter cloth that would signal that there was still a degree of remnant agglomeration of carbon particles.

In the form where the start or batch material employs dimethylformamide as the solvent and polyethylene or propylene glycol as the polymer base, it constitutes an ideal material to serve as a coating or a base or carrier material.

According to a further aspect of the invention a web or sheet is formed by applying a quantity of finished compound as discussed above to a release paper by way of transfer coating, to achieve a uniform coating or film of compound between 90 and 100 grams per square meter dry weight, and subjecting the web or sheet to heat progressively rising from 110°C to 150°C to achieve the controlled release of solvents and provide a coating or film free of pinholes.

As the electrical conductivity, and hence the heating effect achievable is a function of coating or film thickness the above process is repeated until a desired thickness of coating or film is created.

At this stage considerable care must be exercised to ensure that reticulation is avoided, and as it is preferred to spread the finished compound on the release paper by employing a doctor blade, equally considerable care exercised to ensure the avoidance of the presence of dirt or grit on the blade edge, to prevent the creation and spread of lines of indentations in the coating or film.

Desirably, the release paper is matt grade and is an unembossed silicone-coated paper.

According to a still further aspect of the invention, a flexible fabric able to serve the purpose of an electrical conductive heater is formed by taking the release paper mentioned above with its coating of finished compound spreading thereon a further quantity of said compound, laying the release paper on a flexible fabric carrier sheet or web, and passing the composite through a fixed gap roller to ensure controlled penetration of said compound into the fabric of the sheet or web, the sheet or web thereafter being subjected to heat progressively rising from 110°C to 150°C to achieve controlled release of solvents and provide a coating of film free of pinholes. Also possible is the direct application of a coating of finished compound directly on to a fabric carrier.

Such a sheet or web can be of any desired length, and of any width with the limits of available fixed gap rolls.

By the nature of the coat or film, there is a substantially totally even spread of carbon black at loadings in the polymer material considerably beyond that which has hitherto been believed to be possible whilst at the same time leaving the fabric with its film or coat totally flexible.

The fabric may be a knitted cotton material but can be of any other suitable form, such as a weft knitted polyvinyl alcohol fabric.

The preparation of the said compound and the manner of its application to a carrier is such that a visually smooth coating or film is provided. However, it remains so that the coating will exhibit a microscopic degree of roughness with peaks and troughs formed by carbon particles at the exposed surface. It is then important to pay special attention to the provision of an electrical connection to the coat or film.

According to yet another aspect of the invention an electrical connection to a coat or film incorporating carbon particles is formed by first spraying a nickel compound to an area of the coat or film, and applying to the sprayed area a tin-copper tape coated with a silver loaded conductive adhesive. With the electrical connection installed, the sheet or web can be connected to a suitable power source with the substantial guarantee that there will be no shorting or arcing at the point of electrical connection, and consequently no damage by the creating of hot spots.

Dependant on the use to which the sheet or web is put, an electrical connection can be provided over long lengths to opposite edges, to assist in the even input of power to the coat or film over a wide area, by locating a conductive rail on the silver loaded conductive tape. Desirably, the conductive rail is overlaid by an antifaying compound, preferably wider than the

rail.

An important aspect of the invention is that the totally uniform heating effect achievable in the coat or film can be with relatively low power, eg 24 volts, and by controlling the width between the electrodes or rails, and the thickness of the coat or film, a constant temperature can be achieved and maintained, at any required level to serve a particular purpose.

In its form as a flexible sheet or web, an outer insulating layer can be sprayed on to form a water/fluid resistant electrical insulator. Suitable materials may be polyurethane, silicone or acrylic elastomers. The invention has a considerable number of available uses. It can be wrapped round an article the temperature of which is to be maintained and equally can be incorporated into clothing for use in extremely cold climates, to maintain the temperature of the wearer.

However, the fabric has significant benefits when used in medical contexts. It can be incorporated in a mattress or as a blanket for an operating table or for a bed in the recovery ward for raising and maintaining the temperature of patients following surgery.

It is possible to employ the fabric in sleeping or carrying bags for use by rescue services to give immediate aid to accident victims suffering from hyperthermia.

In all such uses, the low voltage required means that there is total safety to the user. The voltage and coat or film thickness can determine the maximum and constant temperature across the full width and length of the fabric.

The arrangement may be that power is supplied to the electrically conductive heater until such time as its required temperature is reached and then maintained at that temperature by an appropriate switching arrangement to switch power ON and OFF as required. It is however preferred for power to be supplied as a series of pulses of predetermined time, with intervening

periods where power is switched off for predetermined periods of time, to allow temperature sensing to take place. Irrespective of the form of power supply, the invention allows highly efficient use of electrical power.

In addition to being able to control maximum temperatures by voltage control by control of the spacing between electrodes and by coating thickness it is a highly advantageous feature of the invention that the predetermined maximum temperature to suit the application is achieved in reasonable time from the onset of power, after which the temperature is regulated and maintained at its predetermined level. This can be of considerable importance not only in medical contexts but also in such as the food industry and particularly in food processing where a required temperature must be achieved quickly and maintained.

In addition to its use in conjunction with a flexible fabric, the said compound can be used differently. For example, it may be sprayed onto products whereby to provide heat uniformly over the whole surface of a complex product. The said compound can be screen printed onto support surfaces, or can be directly coated on to a product surface. Equally it can be calendered or hot melt coated from dry compound to produce flexible sheets, or can be applied by a powder coating technique to produce heatable laminates.

A further possibility within the invention is to provide a said compound where the polymer material into which the carbon black is stirred is such as to make the compound suitable for moulding or casting. Thus, form- stable sheets or shapes of material can be produced that can be used in a number of industrial applications, such as sub floor heater pads, sub soil heater pads, linings for fly ash hoppers in power stations the temperature of which needs to remain constant to avoid the ash from becoming damp, or placement around such as pump and valve castings, to prevent them from freezing and hence malfunctioning. In addition the said compound can be

moulded around vessels for warming chemical or liquids.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic part sectional perspective view of a mattress or blanket containing a conductive material in accordance with the invention;

Figure 2 is a schematic plan view of a mattress or blanket as in Figure 1;

Figures 3 is an upper and view of an electrical connection to the conductive material;

Figure 4 is an exploded perspective view of the electrical connector of Figure 3;

Figure 5 is an electrical block diagram illustrating an electrical circuit able to cause the heating of and the maintenance of a constant temperature in the conductive material; and

Figure 6 and 7 are schematic illustrations of a blanket essentially as shown in Figure 1 formed as a wrapping or a surround for a product structure or pipe;

In Figure 1, a blanket or mattress 1 has a core 2 formed by conductive material 3 on a fabric support 4. The conductive material was produced by the method hereinbefore defined, and applied to the fabric layer as a series of coatings, with each coating heated to 110°C to 150°C by passing through an oven or a series of ovens before the application of a succeeding coating. For medical use, the coating can be 144 microns thick. The conductive material 3 on its fabric support 4 is overlaid by an electrical insulating layer 5, and both encased in a flame retardant insulation 6, of greater thickness to the rear or non-operative side 7 than to the front or operative side 8.

The whole composite is encased in an outer casing 9 of a polyurethane material, and the edges fully sealed around the full periphery of the blanket or mattress, to ensure that the blanket or mattress is totally waterproof, and readily cleanable and sterilisable.

On the conductive material 3 and below the electrical insulating layer 5, is a conductive rail 10 which, as is shown more particularly by Figure 2, lies along the edges of the conductive material along its two longer lengths. For medical use, the spacing between the rails may be 460 mms.

The provision of a guaranteed electrical connection to the conductive rail is of particular importance, and arcing or shorting of the electrical supply must be avoided. Of a separate significance is the supply of current to the conductive material within the blanket or mattress, and as shown in Figures 1, 3 and 4 this is achieved by applying a coating 11 of nickel over the length and width of the conductive material to be occupied by the conductive rail 10 on to which is applied a silver loaded adhesive tape 12 to which the rail 10 is attached. Overlaying the rail 10 is an antifaying compound 13 to guarantee the absence of any electrical arcing. Extending through co-operating apertures in the conductive layer, the nickel coating and the adhesive tape is a conductive stud 14 extending to a stud base 15 soldered to the rear face of the conductive material 3, the stud passing through the fabric backing to cap 16, the cap being crimped to provide a connection to an electrical lead 17. Figure 5 is an exploded view showing the connection.

As indicated in Figure 2, thermocouples or thermisters 18 chosen to suit a particular use of the blanket or mattress (thermistors for sensitive applications and thermocouples for more robust applications), are strategically located on the conductive material, with leads extending to a connection 19. As indicated in Figure 5, there is a control unit 20, from where emerge electrical leads 21 for the conductive studs 14, there being a one shot or resettable fuse 22 provided in the lead extending to one of the conductive studs 14.

The blanket or mattress discussed above is ideally suited to medical use to serve as a

mattress or overlay for an operating table in a theatre or a recovery bed in a recovery room, or as a blanket to overlie a patient. Here the more sensitive thermistor would be employed to sense the temperature of the mattress overlay or blanket. As indicated in Figure 5, the mattress overlay or blanket is connected to a control unit 23 in turn connected to a transformer unit 24 that itself is connected to a mains supply. This ensures that low voltage supply, preferably at 24 volts is supplied to the mattress overlay or blanket.

Figure 5 illustrates in block diagram form the electrical circuit from the mains to the blanket or mattress. At the transformer unit 24, there is the mains input leading to a filter 25 and the low voltage transformer 26. This ensures the feeding of 24 volt supply to the control unit 23. From the inlet, power is supplied to a switching circuit 27, and then to an over temperature isolation circuit 28 from where it progresses to a power output for connection to the mattress overlay or blanket as has been described above. Simultaneously, power is supplied to a control module 29 having a temperature control means 30 and outputs connected to a visual alarm 31 an audible alarm 32 and to the switching circuit 27. The temperature sensing thermistors (or thermocouples) 18 on the mattress overlay or blanket are connected to the control unit 23, to provide signals to the temperature isolation circuit 28 denoting temperature. An alarm test 33 is provided on the unit, the alarm test being connected to the control module, and able to simulate an over temperature condition.

Immediately prior to the onset of operations, the temperature control means is set to a temperature required of the blanket or mattress, typically average human body temperature. The transformer unit and hence the control unit and mattress overlay/blanket are connected to a mains supply, and the alarm test activated to confirm that all circuits are active.

The switching circuit is such that at the outset, power is supplied to the mattress overlay

or blanket for a predetermined period of time, typically one minute and switched off for a second predetermined period of time, typically 10 seconds. During the period that power is switched off, the temperature sensed by the thermistors 18 is signalled via the control module 29 to the over temperature isolation circuit 28, and if the temperature sensed is lower than the pre-set temperature, power is repeatedly switched on and off and the temperature sensed, until the temperature of the blanket or mattress is that required. When in that condition, power is held off until a fall in temperature of the blanket or mattress is sensed.

With a patient on the mattress overlay, or wrapped in the blanket, any fall in body temperature causes an extraction of heat from the mattress or blanket, immediately sensed by the thermisters, and signals sent to the over temperature control circuit and switching circuit to cause the pulsed supply of power to recommence until such time as the temperature of the blanket or mattress recovers to the pre-set level.

By virtue of the method of producing the carbon laden material at its carbon to polymer density, and as a consequence of the manner of its application to a support fabric, there is the substantially uniform heating over the whole area of the blanket, with a substantially total elimination of hot and cold spots the result of which is that there is total support for the body heat of a patient over his or her full height and width, ensuring that body temperature control crucial to a patient during operations and subsequent recovery, is maintained.

In the most unlikely circumstances that the blanket or mattress should overheat, both the visual and audible alarms are activated, and the over temperature isolation circuit switched to prevent further power supply to the blanket or mattress. To guard against over temperature being consequent on a momentary surge of power, over temperature sensed during a first ten second switch-off of power can be caused to be ignored, and activation of the alarms and

temperature isolation circuit activated only if over temperature is sensed during the second of two successive periods of switch-off of power and temperature sensing.

The above described construction of blanket or mattress and its control, whilst ideally suited to medical applications, can be used without essential changes for other more industrial uses.

As is schematically suggested in Figures 6 and 7 a generally rectangular construction 34 of essentially the same nature as is illustrated in Figure 1 can be used to wrap round an item 35 that needs to be heated.

That item could be a domestic hot water tank, when a uniform heating effect is provided over its whole height, to the considerable benefit of the saving of power by creating a more rapid heat up from cold and a far more efficient maintenance of the temperature of water in the tank.

The item could be e.g. pipework in, e.g. the food industry where the invention can provide both an insulating lagging of pipework through which heated and fluid foodstuffs must flow and the provision of uniform heating over the full pipe work length. Not only does this have major importance during normal operations, but should there be the need to close down operations for any reasons, foodstuffs can solidify. Hitherto, solidified oil-based products in pipe lines has been a major problem. With the invention, recommencement of the provision of heat to the blanket and hence to the pipework has the effect of gently and speedily re-heating the foodstuff to bring it back to a fluid state when flow can recommence.

The item could equally be one of outdoor use in extremely cold climates such as for example valves and pumps, that can be encased in the material of the invention to maintain them at a temperature that allows them to function normally no matter what the ambient temperature might fall to.

CLAIMS

1. A conductive material characterised by finely divided carbon particles uniformly dispersed in an elastomeric carrier there being carbon particle levels of 20% by weight to 75% by dry weight to 80% to 25% by dry weight of carrier levels.

2. A conductive material as in Claim 1, characterised in that carbon particle levels of 20% to 40% by dry weight to 80% to 60% by dry weight of carrier levels are used.

3. A conductive material as in Claim 1 or Claim 2, characterised in that the carbon particles are so-called carbon black, a finely divided powder, and the elastomeric carrier is an elastomeric polymer.

4. A conductive material as in any of Claims 1 to 3, characterised in that a semiconductive film or coating comprises a carbon filled elastomeric polymer with carbon particle levels of 43% to 73% by dry weight to 57% to 27% by dry weight polymer levels.

5. A conductive material as in Claim 4, characterised in that the carbon particle level is 60% to 65% dry weight to 40% to 35% dry weight of polymer levels.

6. A conductive material as in Claim 4 or Claim 5, characterised in that the carbon particle level is 57% by dry weight to 43% by dry weight of polymer.

7. A conductive material as in any of Claims 3 to 6, characterised in that the elastomeric polymer is an aliphatic polyurethane in solution.

8. A method of forming a compound for an electrically conductive heater characterised by stirring fine carbon particles into a polymer base containing an anti-adsorption compound, to achieve carbon particles to polymer levels of 20% by dry weight to 75% by dry weight to 80% to 25% by dry weight of polymer, and subjecting mixture to high speed stirring for a pre-determined period of time, with the maintenance of the mixture below a predetermined level, to

grind the carbon particles to a predetermined final fineness.

9. A method of forming a compound for an electrically conductive heater as in Claim 8, characterised in that the predetermined temperature level is not more than 25°C.

10. A method of forming a compound for an electrically conductive heater as in Claims 8 and 9, characterised in that the viscosity of the mixture is modified by the addition of a suitable solvent such as dimethylformamide.

11. A method of forming a compound for an electrically conductive heater as in Claim 10, characterised in that the solvent is dimethylformamide.

12. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 11, characterised in that the carbon black particles have particulate size of approximately 30 En nm.

13. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 12, characterised in that the adsorbants may be selected from the group containing polypropylene glycols, polyethylene glycols of a required molecular weight.

14. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 13, characterised in that a polymer solution is added to the master batch such that the ratio of polymer to carbon black is 1:0.57 on a dry basis.

15. A method of forming a compound for an electrically conductive heater as in Claim 14, characterised in that the polymer solution is aliphatic polyurethane.

16. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 14, characterised in that the finished compound is refiltered prior to use.

17. A method of forming a compound for an electrically conductive heater as in any of Claims 8 to 16, characterised in that the first stirring of fine carbon particles in to the polymer

base is a slow stirring, and the high speed stirring is limited to not more than 30 minutes.

18. A web or sheet to serve as an electrically conductive heater, is characterised by applying a quantity of finished compound as in any of Claims 1 to 17, to a release paper by way of transfer coating, to achieve a uniform coating or film of compound between 90 and 100 grams per square meter dry weight, and subjecting the web or sheet to heat progressively rising from 110°C to 150°C to achieve the controlled release of solvents and provide a coating or film free of pinholes.

19. A web or sheet as in Claim 18, characterised in that a number of coatings are applied to achieve a desired thickness of coating or film.

20. A web or sheet as in Claim 18 or Claim 19, characterised in that the release paper is matt grade and is an unembossed silicone-coated paper.

21. A flexible fabric able to serve the purpose of an electrical conductive heater is formed by taking a release paper with a coating of finished compound spreading thereon a further quantity of said compound, laying the release paper on a flexible fabric carrier sheet or web, and passing the composite through a fixed gap roller to ensure controlled penetration of said compound into the fabric of the sheet or web, the sheet or web thereafter being subjected to heat progressively rising from 110°C to 150°C to achieve controlled release of solvents and provide a coating of film free of pinholes.

22. A flexible fabric able to serve the purpose of an electrical conductive heater, characterised in that a coating of finished compound as in any of Claims 1 to 17 is applied directly to a fabric carrier.

23. A flexible fabric able to serve the purpose of an electrical conductive heater as in Claims 21 and 22, characterised in that the fabric is a knitted cotton material.

24. A flexible fabric able to serve the purpose of an electrical conductive heater as in Claims 21 to 23, characterised in that the fabric is a weft knitted polyvinyl alcohol fabric.

25. An electrical connection to a coat or film incorporating carbon particles, as defined in any of Claims 1 to 24, characterised by first spraying a nickel compound to an area of the coat or film, and applying to the sprayed area a tin-copper tape coated with a silver loaded conductive adhesive.

26. An electrical connection to a coat or film incorporating carbon particles as in Claim 25, characterised in that the conductive rail is overlaid by an antifaying compound, preferably wider than the rail.

27. A web or sheet as in Claims 18 to 26, characterised by the presence of an outer insulating and water/fluid resistant layer totally encasing the web or sheet.

28. A web or sheet as in Claim 27, characterised in that the water/fluid insulating layer is a polyurethane, silicone or acrylic elastomer.

29. A method of operating an electrically conductive heater of any of Claims 1 to 28, characterised in that the connection to a source of power is by way of a transformer and a control unit to supply power as a series of pulses of predetermined time with intervening periods where power is switched off for predetermined periods of time.

30. A method as in Claim 29, characterised in that during the periods where power is switched off, the temperature of the heater is sensed by strategically located temperature sensing means, that signal the control unit to continue to supply pulses of power or to signal that a predetermined temperature has been reached and suspend the supply of power.

31. A method of providing an electrically conductive heater on a product or an installation, characterised by spraying, screen printing or directly coating the compound as

defined in any of Claims 1 to 17 on to the product or installation.

32. A method of providing an electrically conductive heater for a product or an installation, characterised by the employment of an appropriate polymer material into which the carbon particles are stirred that makes the compound suitable for moulding or casting to provide preformed shapes for application to a product or installation.

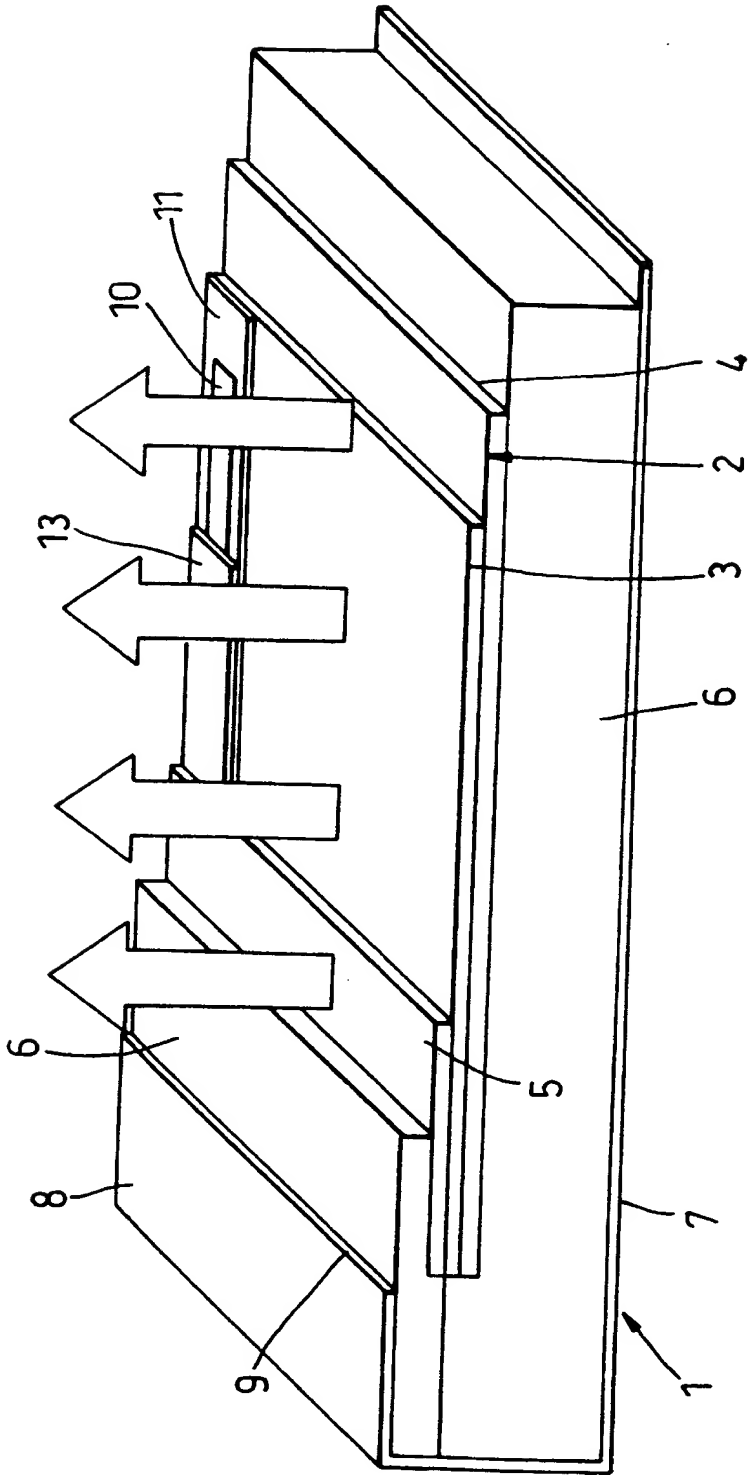


Fig. 1

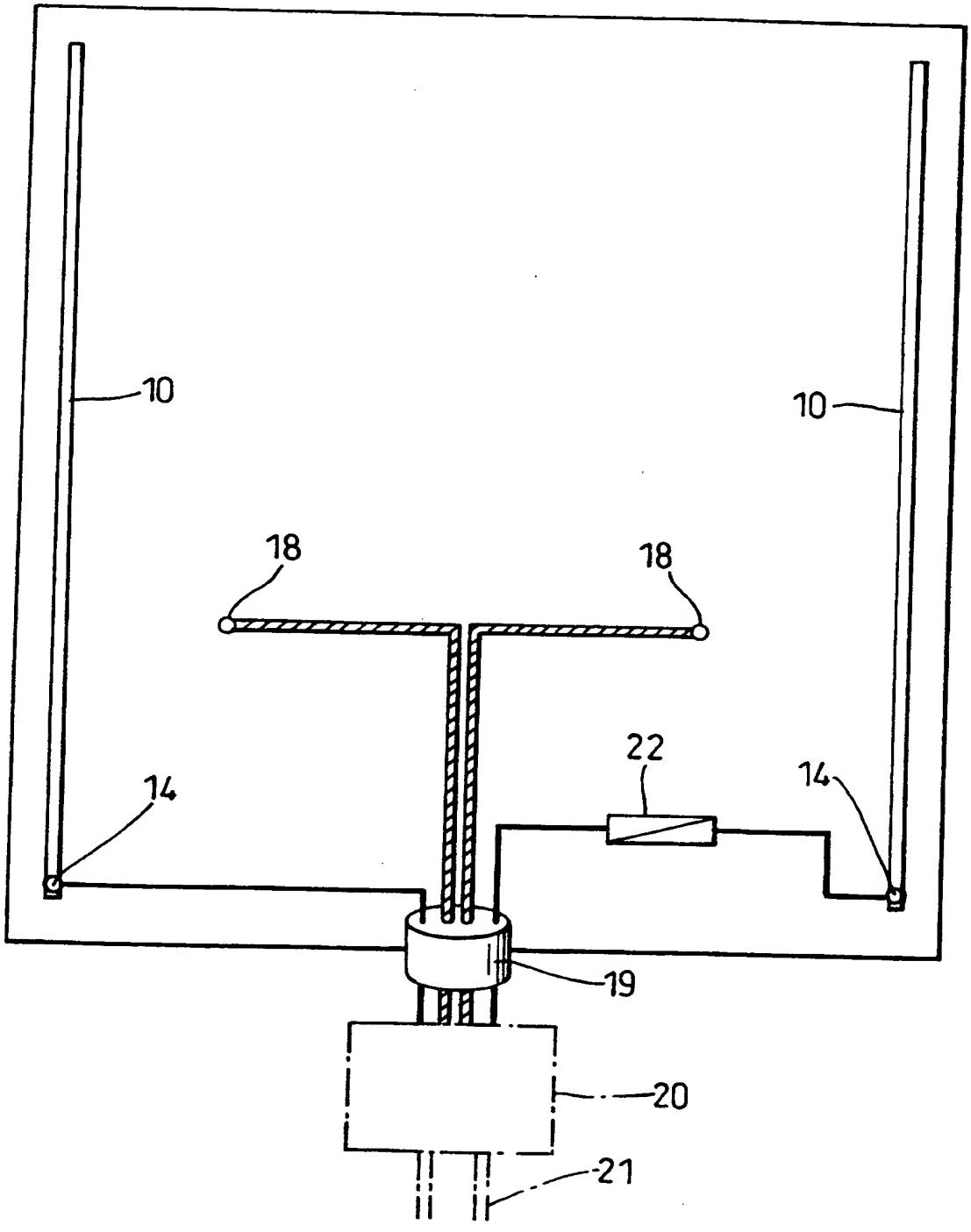


Fig. 2

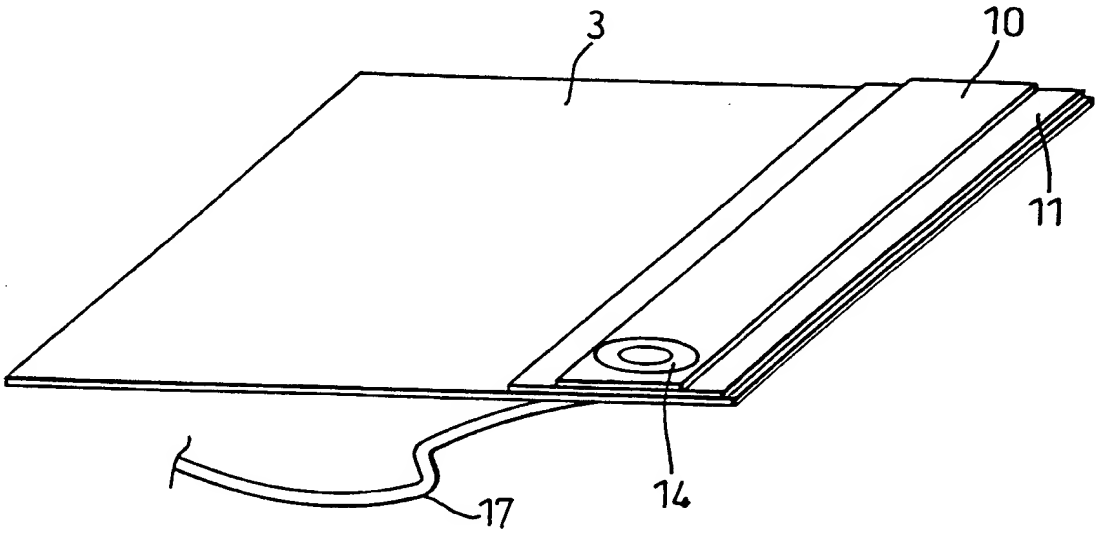


Fig. 3

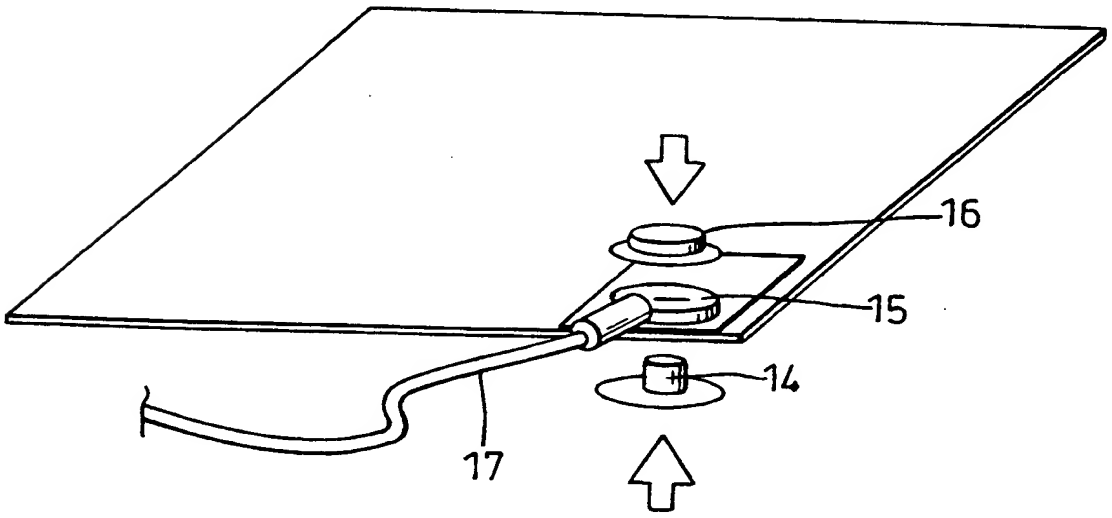
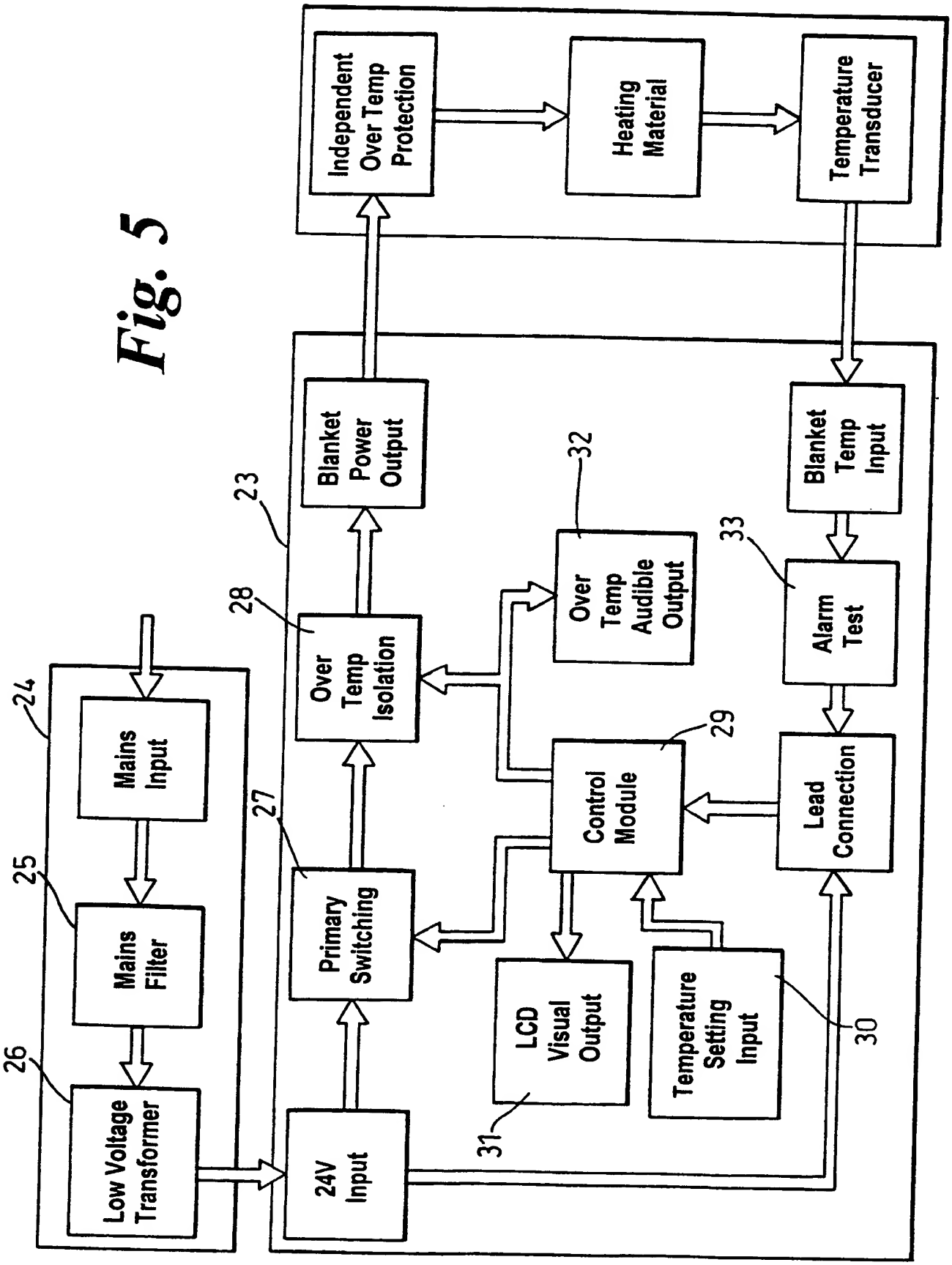


Fig. 4

Fig. 5


Independent Over Temp Protection
Heating Material
Temperature Transducer
Blanket Power Output
Blanket Temp Input
23
32
33
Over Temp Audible Output
Alarm Test
28
Over Temp Isolation
24
Mains Input
29
Control Module
Lead Connection
27
25
Mains Filter
Primary Switching
LCD Visual Output
Temperature Setting Input
30
26
Low Voltage Transformer
24V Input
31

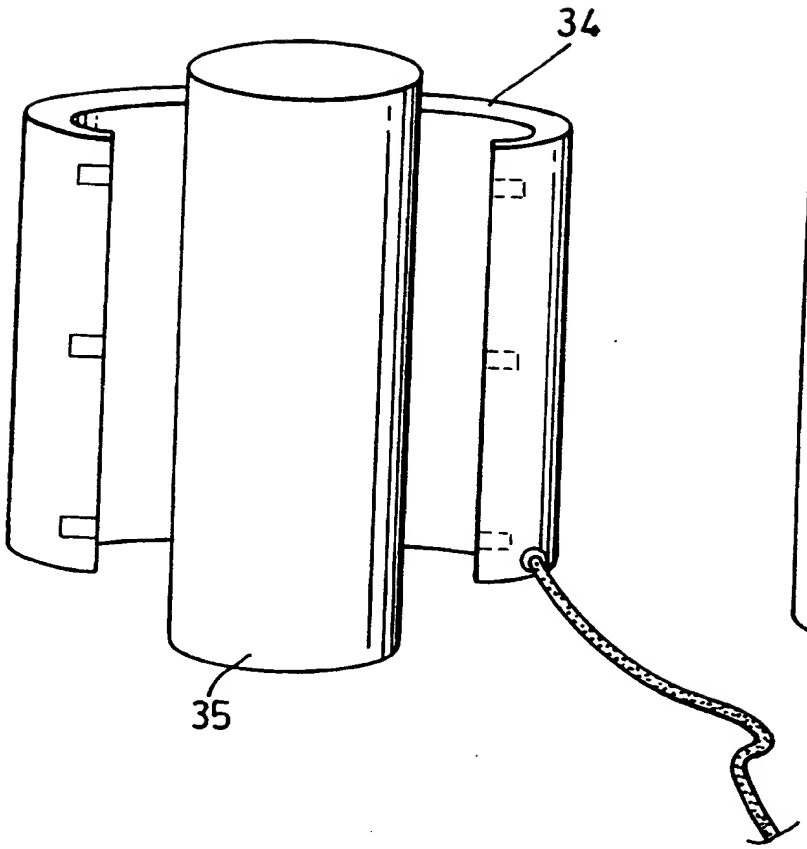


Fig. 6

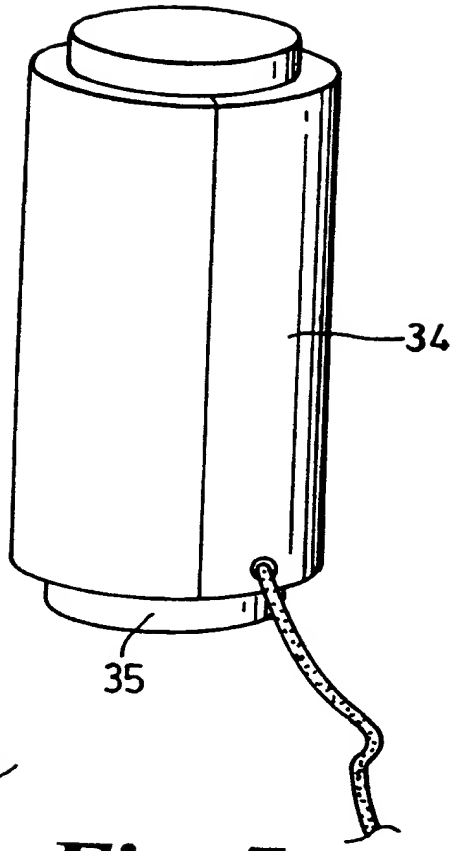


Fig. 7

INTERNATIONAL SEARCH REPORT

Int. ational Application No
PCT/GB 99/04087

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01B1/24 C08K3/04 H05B3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01B C08K H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 5 902 518 A (KHAZAI BIJAN ET AL) 11 May 1999 (1999-05-11) the whole document	1-8,12, 32
A	WO 94 24678 A (ROMANIEC KAZIMIERZ CZESLAW) 27 October 1994 (1994-10-27) the whole document	1-23, 29-32
A	US 5 250 228 A (BAIGRIE STEPHEN ET AL) 5 October 1993 (1993-10-05) claims 1-14	1-8
A	WO 92 04718 A (RAYCHEM CORP) 19 March 1992 (1992-03-19) the whole document	1-8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 February 2000	07/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Drouot, M-C

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/04087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 344 734 A (MATSUSHITA ELECTRIC IND CO LTD) 6 December 1989 (1989-12-06) claims 1-12	1-8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ational Application No
PCT/GB 99/04087

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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